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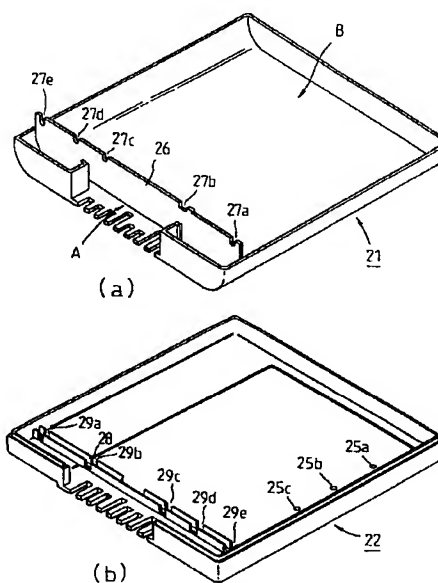
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(54) **Battery pack**

(57) Disclosed is a battery pack that can appropriately prevent a fire that results from the ignition of gas that is produced by the vaporization of an electrolyte, even when the ambient temperature of the battery cell is increased due to heat that is generated by an incorporated electric circuit or by overcharging.

According to the present invention, a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of said battery cells, comprises: a case for said battery cells that includes a partition wall for defining a battery chamber, for containing said battery cells, and an electric circuit chamber, for containing said electric circuit, wherein said electric circuit is isolated from an atmosphere in said battery cell chamber by said partition wall.



**FIG 4**

## Description

### Field of the Invention

The present invention relates to battery packs in which are integrally packaged one or more cells and an electric circuit.

### Background of the Invention

At the present time, compact and light electric/electronic apparatuses are being manufactured and are in wide use for which portability has been a design consideration. So-called notebook computers (or portable computers) are good examples. Such portable electric/electronic apparatuses can be driven by their incorporated batteries even at sites, such as outdoors, where there are no commercially available power sources (normally, AC power sources).

Many incorporated batteries are actually formed as a "battery pack", wherein a plurality of battery cells are connected and packaged, in order to obtain an adequate output voltage level for driving an electric/electronic apparatus and a power capacity that is sufficient for operation over an extended period of time. In consonance with recycling considerations, rechargeable battery cells are employed. The rechargeable batteries are, for example, nickel-cadmium (Ni-Cd) batteries, nickel-hydrogen (NiMH) batteries, and ion batteries, such as lithium ion (Li-Ion) batteries. Conventionally, from the view point of reliability and maintenance, batteries, such as Ni-Cd batteries and NiMH batteries, that employ a soluble electrolyte are frequently adopted. At present, however, there is a demand for the use of lithium ion batteries, and the scale of the potential market is considered to be large. Since ion batteries have a high energy density per weight (Wh/kg) and a high energy density per volume (Wh/l), they conform to the trend towards the reduction in the size and the weight of portable electric/electronic apparatuses.

Many electric/electronic apparatuses that employ a rechargeable battery pack also incorporate an electric circuit for the control of charging and discharging. The electric circuit that controls the charging and the discharging measures data, such as the output terminal voltage of a battery pack, the quantity of a current at the time of charging and discharging, and the internal temperature of the battery pack, that are required for the control of the charging and the discharging, and reports these data externally (e.g., to the body of an electric/electronic apparatus). The control of the charging and the discharging varies in consonance with the hysteresis and the specifications for a battery pack. In addition, a battery pack may be replaced by another pack when necessary, but an electric/electronic apparatus can not manage all types of battery packs. Currently, therefore, battery packs (so-called intelligent batteries) have appeared that incorporate a controller and various sen-

sors, and that manage the beginning and the completion of the charging and the discharging and report it to the bodies of electric/electronic apparatuses. The notebook computer "ThinkPad 750" (a trademark of IBM Corp.) sold by IBM, employs an intelligent battery. The advantages of an intelligent battery are that it relieves an electric/electronic apparatus from the work load that is imposed by the management of a battery pack, and that it contributes to a reduction in the size of and in the space that is required for a power source in the electric/electronic apparatus.

Since a property of the lithium in the lithium ion battery is that it reacts violently with water, generally, an inflammable organic solvent is employed as an electrolyte, and gas that is generated by the vaporization of the electrolyte may leak from the battery cell. When leaking electrolyte drops onto an electric circuit, a short circuit may occur or the electrolyte may come into contact with a heat generator and thereby cause a fire; and when the ambient temperature of the battery cell is increased due to overcharging, the vaporization of the electrolyte may be aggravated. In addition, when a lithium ion battery is employed as the above described intelligent battery, a controller chip and an amplifier can constitute a heat generator for triggering a fire. Further, due to heat that is generated, the electrolyte may spout out and cause a fire to become larger. Since an incorporated battery pack is mounted in a predetermined space in an electric/electronic apparatus, not only will the battery pack be destroyed by the fire it originates, but also peripheral devices around the pack may be damaged.

Such battery packs may be incorporated in a portable electric/electronic apparatus, and may include battery cells, such as lithium ion batteries, for which an insoluble electrolyte (i.e., an inflammable organic solvent) is employed. It is a problem with such battery packs that, when the ambient temperature of the battery cell is increased due to the generation of heat by an incorporated electric circuit or by overcharging, fires may be caused by a gas that is produced by the vaporization of an electrolyte or by the leaking of the electrolyte.

To overcome the above shortcomings, there is one proposed method that calls for a single battery cell to be designed with a completely sealed structure to prevent the leakage of electrolyte and gas that is generated when it is vaporized. When a battery cell is completely sealed, however, excess energy that is generated inside of the battery cell can not escape, and thus, a rather large explosion could occur (commonly, a battery cell is formed with an enclosing can and a sealing plate for closing the top face, with safety holes being bored in the sealing plate so that gas that is generated as the internal pressure increases can be discharged externally as needed.)

Finally, for the employment of an ion battery cell, such as a lithium ion battery, a safety structure is required that differs from that of a conventional battery cell, such as a Ni-Cd or a NiMH cell.

### Disclosure of the Invention

Accordingly, according to a first aspect of the present invention, a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, comprises: a case for the battery cells that includes a partition wall for defining a battery chamber, for containing the battery cells, and an electric circuit chamber, for containing the electric circuit, wherein the electric circuit is isolated from an atmosphere in the battery cell chamber by the partition wall.

According to a second aspect of the present invention, a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, comprises: a case for the battery cell that includes a partition wall for defining a battery chamber, for containing the battery cells, and an electric circuit chamber, for containing the electric circuit, wherein the electric circuit is isolated from an atmosphere in the battery cell chamber by the partition wall, and wherein at least one safety hole is formed in a battery cell side of the case in order to release an electrolyte that leaks from the battery cells, or gas that is produced by the vaporization of the electrolyte.

According to a third aspect of the present invention, a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, comprises: a case for the battery cells that includes a partition wall for defining a battery chamber, for containing the battery cells, and an electric circuit chamber, for containing the electric circuit, wherein the electric circuit is isolated from an atmosphere in the battery cell chamber by the partition wall, and wherein an essential portion of the electric circuit is covered with insulating material.

According to a fourth aspect of the present invention, provided is a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, wherein the battery cells are so located that positive terminals of the battery cells are on the sides that do not face toward the electric circuit.

According to a fifth aspect of the present invention, provided is a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, wherein the battery cells are so located that a sealing plate for the battery cells is on the side that does not face toward the electric circuit.

According to a sixth aspect of the present invention, provided is a battery pack, in which are integrally packaged one or more battery cells and an electric circuit for controlling charging and discharging of the battery cells, wherein the battery cells are so located that a safety hole for the battery cells is on the side that does not face toward the electric circuit.

According to a seventh aspect of the present invention, a battery pack is provided wherein the case of the battery pack employs polycarbonate as a base and is toned with nonflammable dyes.

According to the first, the second and the third aspect of the battery pack of the present invention, even when an electrolyte (an inflammable organic solvent) and gas that is produced from its vaporization leaks from a battery cell, an electric circuit is isolated by a partition wall and thus is not contacted by the electrolyte. Although included in the electric circuit are heat generators, such as a controller chip and an analog circuit, as the circuit is not contacted by the electrolyte, ohmic short circuits (short circuits with resistance) and fires that are caused by the short circuits will not occur.

According to the second aspect of the present invention, the gas that is generated by the vaporization of an electrolyte is released externally through a safety hole that is formed in a side of a chamber in which a battery cell is contained, so that little gas invades a chamber in which an electric circuit is contained.

According to the third aspect of the present invention, since the essential portion of an electric circuit is covered with insulating material, ohmic short circuits (short circuits with resistance) will not occur even if a gas vapor enters and dampens that portion.

A cylindrical sealed battery cell is commonly designed to be sealed at its positive electrode side, as will be described later. A mechanical member, such as a safety valve and a safety hole, is provided near the sealed portion to release gas vapor externally as the internal pressure increases. In other words, the battery cell is designed such that gas vapor can leak from the positive electrode side of the battery cell. According to the fourth, the fifth and the sixth aspects, since the positive electrode side of a battery cell (or a side on which a sealing plate and a safety hole are provided) is positioned apart from an electric circuit, it is rather difficult for gas that is generated by the vaporization of an electrolyte to reach the electric circuit.

According to the seventh aspect of the present invention, toning of the case of a battery pack is performed with nonflammable dyes, so that even if a fire originates in a battery cell or an electric circuit, the spread of the fire to the other portions will be greatly inhibited.

Other objects, features and advantages of the present invention will become readily apparent during the following detailed explanation of an embodiment that is given while referring to the accompanying drawings.

### Brief Description of the Drawings

One embodiment of the present invention will now be described in detail while referring to the drawings, in which Fig. 1 is a diagram illustrating an external appearance of a battery cell 1 that is employed for one embodiment of the present invention.

Fig. 2 is a diagram illustrating the internal structure of the battery cell 1;  
 Fig. 3 is a diagram illustrating a battery pack according to the embodiment of the present invention;  
 Fig. 4 is an exploded diagram illustrating a base board and a cover for the battery pack of Fig. 3, with Fig. 4(a) specifically showing the base board and with Fig. 4(b) specifically showing the cover;  
 Fig. 5(a) is a diagram illustrating the external appearance of an electric circuit that is included in the battery pack of Fig. 3; Fig. 5(b) is a diagram illustrating a battery cell assembly and electric circuits; that are mounted in the base board;  
 Fig. 6 is a cross sectional view of the vicinity of a partition wall when the battery pack 20 is assembled, with Fig. 6(a) specifically showing a cross section of a portion where a lead is passed through, and with Fig. 6(b) specifically showing a cross section of a portion other than one where a lead is passed through; and  
 Fig. 7 is a schematic diagram illustrating the structure of the internal circuit of the battery pack.

#### Detailed Description of the Invention

Fig. 1 is a diagram illustrating the external appearance of a battery cell 1 according to one embodiment of the present invention, and Fig. 2 is a diagram illustrating the internal structure of the battery cell 1.

As is shown in Fig. 1, the lithium ion battery cell 1, as well as other secondary batteries, has a cylindrical sealed structure with an enclosing can 2 and a sealing plate 3 that seals the top face. An insulating resin is used to coat the side face of the enclosing can 2, and its exposed bottom serves as the negative terminal of the battery cell 1. A protrusion 13 that is formed almost at the center of the sealing plate 3 serves as the positive terminal of the battery cell 1.

As is shown in Fig. 2, the interior of the lithium ion battery cell 1 is designed as a laminated roll that consists of a positive electrode film 4, separators 6 and a negative electrode film 5, all of which are thin sheets, with the laminated roll being retained in the enclosing can 2.

The positive electrode film 4 is formed of an active material (lithium metal oxide; a specific example being  $\text{LiCoCo}_2$ ) that is bonded to metal foil. The negative electrode film 5 is formed of carbon particles that are bonded to metal foil. The separators 6 are formed of polymer film that electrically separates the positive electrode film 4 from the negative electrode film 5 and permits ions to pass through. A sufficient quantity of an electrolyte (aprotic organic solvent) for carrying electrons is employed to impregnate the positive electrode film 4, the negative electrode film 5 and the separators 6. One end of the positive electrode film 4 communicates with the sealing plate 3 by means of a positive lead 7. One end of the negative electrode film 5 communicates with the bottom face of the enclosing can 2 by means of a neg-

ative lead 8.

The edge around the top opening in the enclosing can 2 is bent inward, and a gasket 9 is retained inside the bent portion. The disk shaped sealing plate 3 and a safety valve 10 are fitted into the opening of the enclosing can and held by the gasket 9. The safety valve 10 is flexible in the axial direction of the cylinder of the battery cell 1 (i.g., upward and downward in Fig. 2). The safety valve 10 is deformed as the internal pressure of the battery cell 1 is increased due to the generation of gas, and breaks the connection between the positive lead 7 and the positive terminal on the sealing plate 3. A safety hole 11 is formed in the sealing plate 3 to provide a port for gas that is generated to pass through and be externally released, and excess energy is thereby prevented from accumulating in the battery cell 1.

An arched break portion that is formed in the bottom of the enclosing can 2 is a safety break valve 12. The safety break valve 12 easily ruptures before excess energy is accumulated in the battery cell 1 and prevents a large explosion.

The output voltage of a single lithium ion battery cell normally is approximately 3.6 [V] (4.3 [V] at the maximum and 2.5 [V] at the minimum), which is three times that of a Ni-Cd battery cell or a NiMH battery cell of almost the same size. As the principle of the charging and the discharging of the lithium ion battery is well known by one having ordinary skill in the art and does not much relate to the subject of the present invention, an explanation for it will not be given.

The above described structure of the battery cell is well known by one having ordinary skill in the art. It should be noted that the feature of the present invention is a battery pack that includes battery cells and that the subject of the present invention is not limited to the detailed structure of the individual battery cells. It will become obvious during the following explanation that a structure of a battery cell other than that which is shown in Figs. 1 and 2 can be employed for a battery pack according to the present invention.

Fig. 3 is a diagram illustrating the external appearance of a battery pack 20 according to the embodiment of the present invention. As is shown in Fig. 3, the battery pack 20 is a flat structure that includes a base board 21, a cover 22, and a head portion 23.

The base board 21, which has a shallow bottom depth, includes battery chambers in which one or more (twelve, in this embodiment) battery cells are retained and an electric circuit chamber in which is provided a printed circuit board 50. On the printed circuit board 50, electric circuits are mounted for controlling the charging and discharging of the battery cells (which will be described later).

The cover 22, which has a shallow bottom depth, covers the top portion of the base board 21. A ribbon 24 is provided on the cover 22, with only one end of the ribbon being fixed to the cover 22, so that to remove the battery pack 20 from an electric/electronic apparatus

(not shown), it is merely necessary to pull the other, free end, of the ribbon 24. Three safety holes 25a, 25b and 25c are formed in the top left side of the cover 22. The safety holes 25a through 25c are employed to externally release gas that is generated in the battery cells by the vaporization of an electrolyte (which will be described later).

At the head portion 23, a plurality of open slots are formed in the upper, the side and the lower faces of the battery pack 20. A pair of terminals are provided on the internal walls of each slot. The positive terminal of the battery pack 20 is assigned to a slot 23-a, the negative terminal is assigned to a slot 23-b, and a control terminal, for exchanging data, such as a remaining battery capacity, with an electric/electronic apparatus (not shown) is assigned to a slot 23-c.

The base board 21, the cover 22 and the head portion 23 can be fabricated of a resin, which has polycarbonate as its base, by using a well known fabrication method. Since polycarbonate is an almost transparent material, and since the interior is visible through it, generally, dyes are added to it for color toning. As black is usually employed as a basic color for current notebook computers, it is therefore popular for the battery pack 20 to also be black so that it matches the color of the computer body. However, the black dyes that are employed for toning are ordinarily carbons (e.g., inflammable material), so that the battery pack 20 may be easily burnt once a fire occurs in the battery cells. In this specification, therefore, it is recommended that noninflammable titanium oxide be added as a toning the color (it should be noted that the color in this case becomes white).

A battery pack that has the similar shape as that in Fig. 3 is disclosed in, for example, European patent application EP 0694980 A2. In addition, such a battery pack is adopted for use in the ThinkPad Models 755CD/755CE/755CSE computers that are sold by IBM Japan, Ltd.

Fig. 4 is an exploded diagram illustrating the base board 21 and the cover 22 of the battery pack 20.

As is shown in Fig. 4(a), the base board 21 has a shallow bottom depth. In the base board 21 is provided a partition wall 26 that defines a front space A (hereafter referred to as an "electric circuit chamber"), for retaining a printed circuit board 50, and a rear space B (hereafter referred to as a "battery chamber"), for retaining battery cells. In the battery chamber B are provided twelve battery cells; six widthwise and two vertically (which will be described later; see Fig. 5). The partition wall 26 is so formed that its height is almost the same as the diameter of the battery cell, and the edge of the partition wall 26 extends to the bottom face of the cover 22 when the cover 22 is closed. Further, five notches, 27a, 27b, 27c, 27d and 27e are formed in the edge of the partition wall 26. Through the notch 27a is passed a negative side lead 52a of the battery cell assembly. Through the notch 27b is passed a terminal 52b of a thermistor that detects the

ambient temperature of the battery cells. Through the notch 27c is passed a positive side lead 52c of the battery cell assembly. Through the notches 27d and 27e are passed leads 52d and 52e for monitoring the terminal voltage at the middle point of the battery cell assembly in the series connection. There is a cut-out portion formed substantially in the center at the front of the base board 21 for attachment of the head portion 23 thereto.

As is shown in Fig. 4(b), the cover 22 has a shallow bottom depth. The sum of the depths of the base board 21 and the cover 22 is almost equal to the diameter of the battery cells. In a groove portion 28 that is formed in almost the front portion of the cover 22 can be fitted to the partition wall 26 of the base board 21. The groove portion 28 has a pair of ribs that run parallel each other. In the groove portion 28, five notches 29a through 29e are formed that correspond to the notches 27a through 27e that are formed in the edge of the partition wall 26. When the cover 22 is attached to the base board 21, silicon rubber is used to coat the groove portion 28, which is then so bonded to the partition wall 26 that there is no gap (which will be described later). Three safety holes 25a through 25c are bored to the rear backward in the bottom of the cover 22. The safety holes 25a through 25c are through holes for the release of gas that is generated by vaporization of an electrolyte, which leaks from the battery cells, to the outside of the battery pack 20. The number of holes is merely determined in consonance with the design choice. There is a cut-out portion almost in the center of the front of the cover 22 for the attachment of the head portion 23 thereto.

Fig. 5(a) is a diagram illustrating the external appearance of electric circuits that are to be included in the battery pack 20. The electric circuits are roughly sorted onto the printed circuit board 50 and a flexible board 51. The printed circuit board 50 has mounted thereon essential electric circuits, such as a voltage comparator 32 and a controller 33 (both of which will be described later), and is stored in the electric circuit chamber A of the battery pack 20. The head portion 23 that includes the output terminal of the battery pack 20 is also provided on the printed circuit board 50. The flexible board 51 is a circuit board on which is mounted wiring for connecting the battery cell assemblies 30a . . . and a thermistor 36 (which will be described later), for detecting the ambient temperature of the battery cells. Since the board 51 is stored together in the battery chamber B with the battery cell assemblies 30a . . . , whose surfaces are not flat, flexible material is employed for the board 51. The five leads 52a through 52e are extended from the flexible board 51 to the printed circuit board 50 (which will be described later).

Fig. 5(b) is a diagram of the battery cell assemblies 30a . . . and the electric circuits (the printed circuit board 50 and the flexible board 51) that are stored in the base board 21. It should be noted that most of the flexible board 51 is cut away to clearly show the arrangement of the battery cells. The battery pack 20 in this embod-

iment has twelve battery cells, which are so provided that their positive terminals face to the rear, i.e., the side opposite to that which is formed by the print wiring board 50, as is shown in Fig. 5(b). The battery cell is so designed that an electrolyte can easily leak from the positive electrode, as is shown in Fig. 3 (the positive terminal is formed with the sealing plate 3 and the safety hole 11 is formed in the sealing plate 3). The devices and terminals (i.e., active portions), to which a relatively high voltage is applied, are mounted on the print wiring board 50 at comparatively short intervals (which will be described later). When such an electrically active portion is moistened by an inflammable electrolyte, an ohmic short circuit can occur that may cause a fire. In this embodiment, therefore, the portion (positive electrode side of the battery cells) from which the electrolyte can leak, and the active portion (the print wiring board 50) are positioned apart from each other.

Fig. 6 (a) and (b) are cross sectional views of the vicinity of the partition wall 26 when the battery pack 20 is assembled respectively with and without a lead 52 passing through. As is described above, since a sufficient quantity of silicon rubber 29 is employed to coat the groove portion 28 of the cover 22, the silicon rubber fills the gap between the groove portion 28 and the partition wall 26 when they are bonded together. The atmosphere in the electric circuit chamber A, for retaining the electric circuits, and that of the battery chamber B, for retaining the battery cells, are completely separated by the partition wall 26. Even if electrolyte in the battery cell is vaporized by the heat that is generated, the gas that is produced will not enter the electric circuit chamber A. Rather, it will be discharged externally through the safety holes 25a . . . that are formed in the battery chamber B.

The "ThinkPad" series of notebook computer that is sold by IBM, for example, has a keyboard arranged upward in the bay in which a battery pack is included. As is well known by one having ordinary skill in the art, the keyboard does not include active items that consume high power. Thus, even if the keyboard is exposed to a gas that is produced by the vaporization of an inflammable organic solvent, which is released through the safety holes 25a . . . , the possibility that a fire will break out is very low.

The structure of the electric circuit in the battery pack 20 will now be explained. It should be noted that the following explanation is given merely to enable the technique that relates to the present invention to be fully understood. The object of the present invention is to prevent ohmic short circuits and the outbreak of fires at the electric circuit, both of which are due to the leakage of electrolyte, and the subject of the present invention is not limited by the structure of the electric circuit.

Fig. 7 is a schematic diagram illustrating the internal circuit structure of the battery pack 20.

In Fig. 7, three battery cell assemblies 30a, 30b and 30c, each of which is made up of four battery cells that

are connected in parallel, are connected in series, and both ends of the assemblies are connected to the positive and the negative terminals of the battery pack 20. The number of battery cells that are connected in series and in parallel is determined by the output terminal voltage and the charging capacity of the battery pack 20 that an electric/electronic apparatus requires (by design choice, in other words). The voltages at the positive and negative terminals P and S of each battery cell assembly, and at terminals Q and R, by which the battery cell assemblies 30a . . . are connected, are transmitted as voltage data to the voltage comparator 32 via respective amplifiers 31a through 31d. The thermistor 36 is provided at the periphery of the battery cell assemblies 30a . . .

The thermistor 36 is a device that changes a resistance in consonance with an ambient temperature (well known), and its output terminal is connected to the controller 33.

The voltage comparator 32 detects the output terminal voltages of the battery cell assemblies 30a . . . and determines whether or not the output terminal voltages have exceeded an overcharge voltage (4.3 [V]) or whether or not the output terminal voltages are lower than the overdischarge voltage (2.5 [V]), and reports the result to the controller 33 across a signal line 34.

A resistor 37 for current-voltage conversion is connected in series to the negative terminal of the battery pack 20. The drop voltage at the resistor 37 is proportional to the output current of the battery pack 20 and is inputted to the controller 33 via an amplifier 38.

The controller 33 employs data for the ambient temperature of a battery cell, which is received from the thermistor 36, and the output current of the battery pack 20, which is received from the amplifier 38, to detect the charging start time for the battery cell and the charging completion time. The controller 33 then sends a charging start request or a charging halt request via a control signal line 35 to an electric/electronic apparatus (not shown). Upon the receipt of the data from the voltage comparator 32, the controller 33 detects the overcharged state or the overdischarged state of any battery cell assembly 30a to 30c, and opens a switch 39 to prevent the battery cells from being destroyed. In this embodiment, the switch 39 is constituted by two FET switches, whose drain terminals face each other and that are connected in series. A combination of other devices (e.g., bipolar transistors) that have equivalent functions may be employed.

The printed circuit board 50, on which the voltage comparator 32, the controller 33 and the amplifiers 31a . . . are mounted, is included in the electric circuit chamber A of the battery pack 20. The battery cell assemblies 30a . . . are retained in the battery chamber B, together with the flexible board 51 on which wiring, for connecting the electrodes of the battery cells, and the thermistor 36 are mounted. The leads 52a, 52b, . . . that extend from the flexible board 51 are inserted through the corresponding notches 27a, 27b, . . . of the partition

wall 26 into the electric circuit chamber A. The edge of the partition wall 26 is covered with silicon rubber 29 (see Fig. 6) and the atmospheres of the chambers A and B are completely separated.

The above described voltage comparator 32 and the controller 33 is provided with a drive voltage that is stabilized by regulators 41 and 42, which employ the output of the battery pack 20 as a power source. Thus, even when the battery pack 20 is not loaded into an electric/electronic apparatus, power is constantly supplied to the circuits 32 and 33, and a relatively high output terminal voltage (about 7.2 [V] or 10.8 [V]) of the battery cell is applied to the leads 52d and 52e. If, as in a conventional case, the electric circuit is mounted on the printed circuit board 50 while the conductive portion of the electric circuit is exposed, that portion may be exposed to the gas that is generated by the vaporization of an electrolyte, or may be dampened by leaking electrolyte, and an ohmic short circuit may occur. In this embodiment, however, since the active portions, such as the leads 52d and 52e, to which a relatively high voltage is applied, are coated with silicon rubber, short circuits and the outbreak of fires can be appropriately prevented.

The present invention has been described in detail while referring to a specific embodiment. However, it should be obvious to one having ordinary skill in the art that various modifications or revisions of the embodiment are possible within the scope of the present invention. In the described embodiment, notebook computers have been employed for explanation. The present invention can be employed for other portable information processing apparatuses (e.g., word processors and other types of OA devices) and battery operating electric/electronic devices, such as portable telephones and portable video cameras.

As is described above in detail, according to the present invention, it is possible to provide a battery pack that can appropriately prevent a fire that results from the ignition of gas that is produced by the vaporization of an electrolyte, even when the ambient temperature of the battery cell is increased due to heat that is generated by an incorporated electric circuit or by overcharging.

According to the first, the second and the third aspect of the battery pack of the present invention, even when an electrolyte (an inflammable organic solvent) and gas that is produced from its vaporization leaks from a battery cell, an electric circuit is isolated by a partition wall and thus is not contacted by the electrolyte. Although included in the electric circuit are heat generators, such as a controller chip and an analog circuit, as the circuit is not directly contacted by the organic solvent, fires will not occur.

According to the second aspect of the present invention, the gas that is generated by the vaporization of an electrolyte is released externally through a safety hole that is formed in a side of a chamber in which a battery cell is contained, so that little gas invades a

chamber in which an electric circuit is contained.

According to the third aspect of the present invention, since the essential portion of an electric circuit is covered with insulating material, ohmic short circuits (short circuits with resistance) will not occur even if a gas vapor enters and dampens that portion.

A cylindrical sealed battery cell is commonly designed to be sealed at its positive electrode side, as is described above. A mechanical device, such as a safety valve and a safety hole, is provided near the sealed portion to release gas vapor externally as the internal pressure increases. In other words, the battery cell is designed that gas vapor can leak from the positive electrode side of the battery cell. According to the fourth, the fifth and the sixth aspects, since the positive electrode side of a battery cell (or a side on which a sealing plate and a safety hole are provided) is positioned apart from an electric circuit, it is rather difficult for gas that is generated by the vaporization of an electrolyte to reach the electric circuit.

According to the seventh aspect of the present invention, toning of the case of a battery pack is performed with noninflammable dyes, so that even if a fire originates in a battery cell or an electric circuit, the spread of the fire to the other portions will be greatly inhibited.

## Claims

1. A battery pack, in which are integrally packaged one or more battery cells (1) and an electric circuit (50) for controlling charging and discharging of said battery cells, comprising:  
a case for said battery cells that includes a partition wall (26) for defining a battery chamber (B), for containing said battery cells, and an electric circuit chamber (A), for containing said electric circuit, wherein said partition wall provides a hermetic barrier between said battery chamber and said electric circuit chamber.
2. A battery pack as claimed in claim 1 wherein at least one safety hole (25) is formed in the battery cell side of said case in order to release any electrolyte that leaks from said battery cells, or gas that is produced by the vaporization of said electrolyte.
3. A battery pack as claimed in claim 1 or claim 2 wherein at least a portion of said electric circuit is covered with insulating material.
4. A battery pack as claimed in claim 3, wherein said insulating material is silicone rubber.
5. A battery pack as claimed in any preceding claim wherein said battery cells are so located that positive terminals of said battery cells are on the sides that do not face toward said electric circuit.

6. A battery pack as claimed in claim 5 wherein said battery cells are so located that a sealing plate (3) for each of said battery cells is on the side that does not face toward said electric circuit.

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7. A battery pack as claimed in claim 6 wherein said battery cells are so located that a safety hole (11) for each of said battery cells is on the side that does not face toward said electric circuit.

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8. A battery pack according to any preceding claim wherein said case of said battery pack employs polycarbonate as a base and is toned with noninflammable titanium dioxide dyes.

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9. A battery pack as claimed in any preceding claim wherein said one or more battery cells employ an inflammable organic solvent as an electrolyte.

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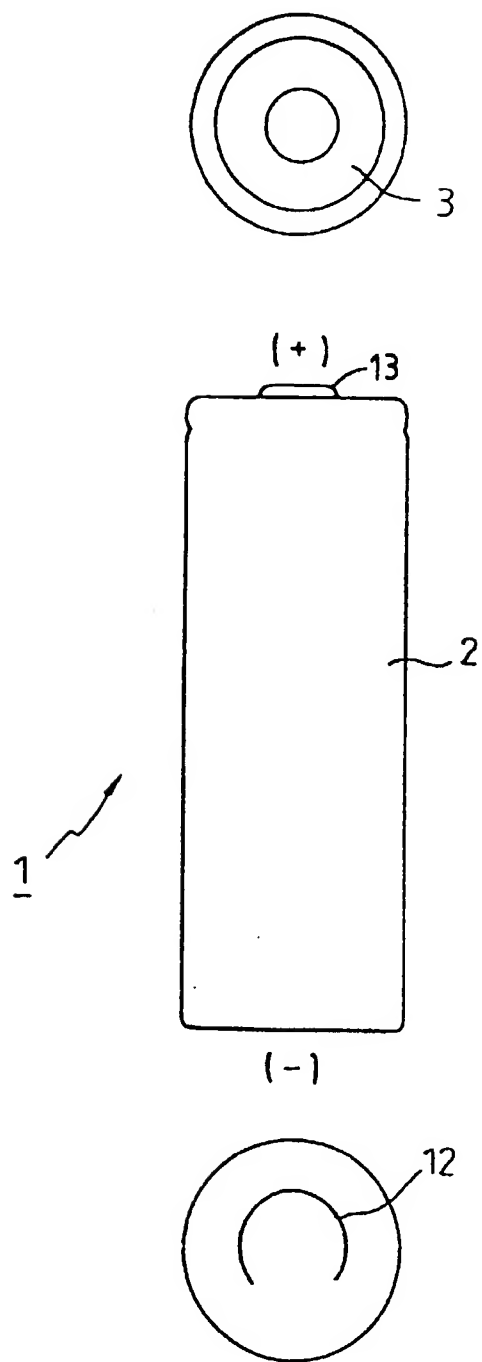


FIG. 1

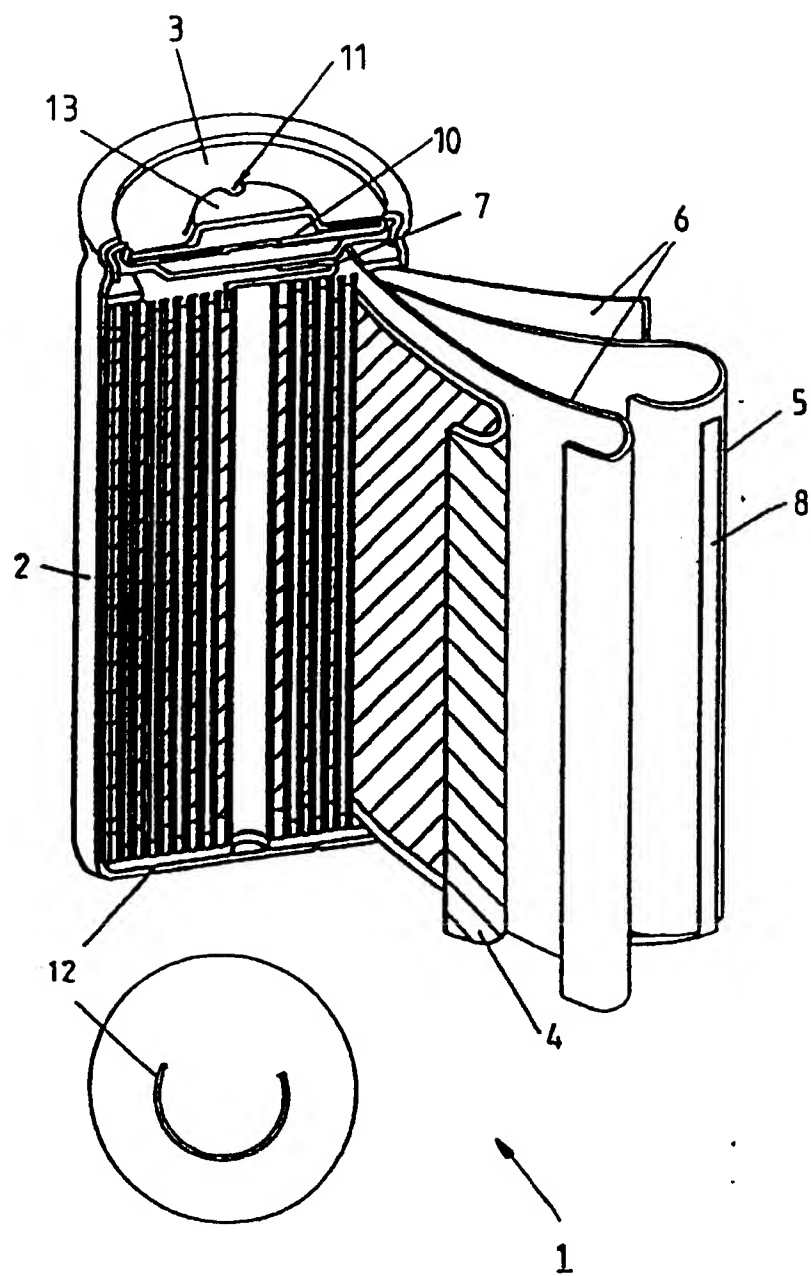


FIG. 2

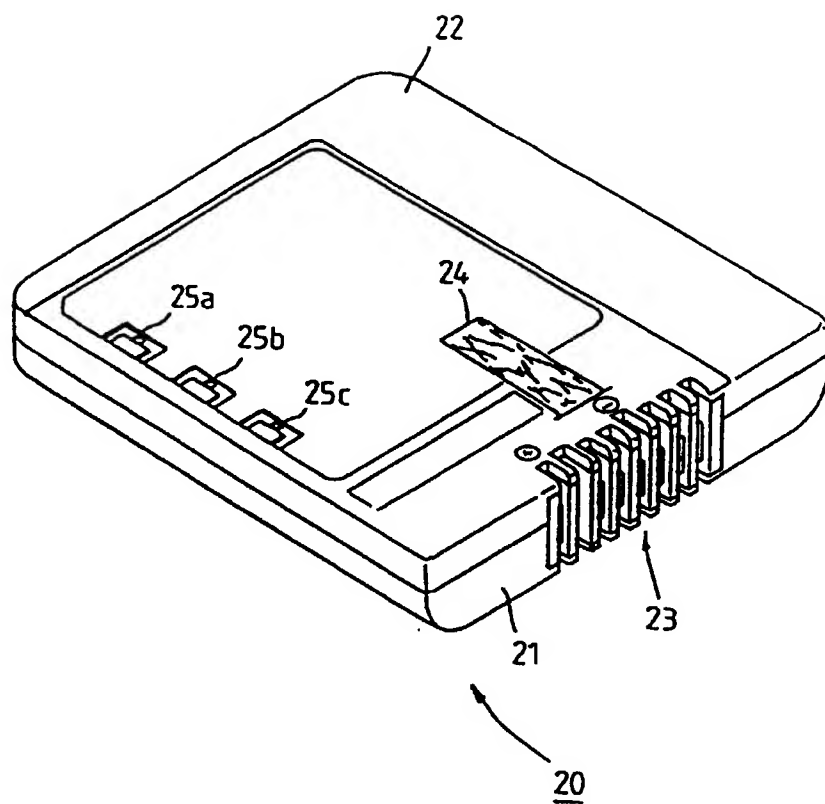
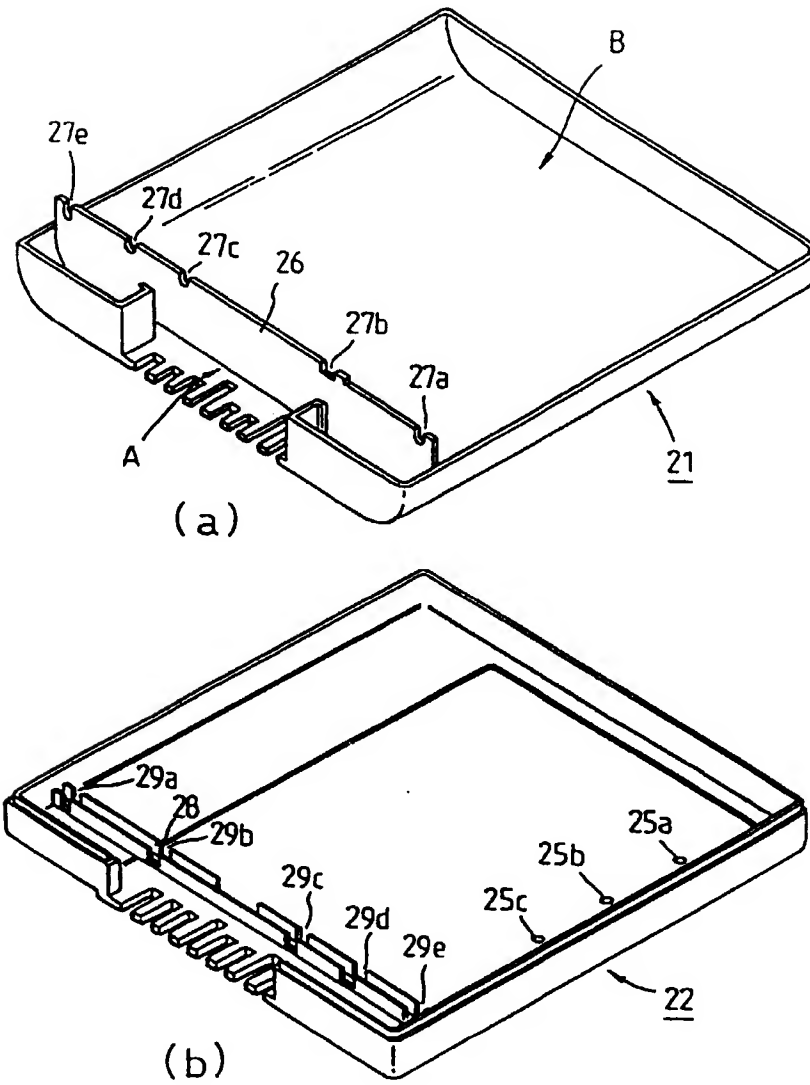
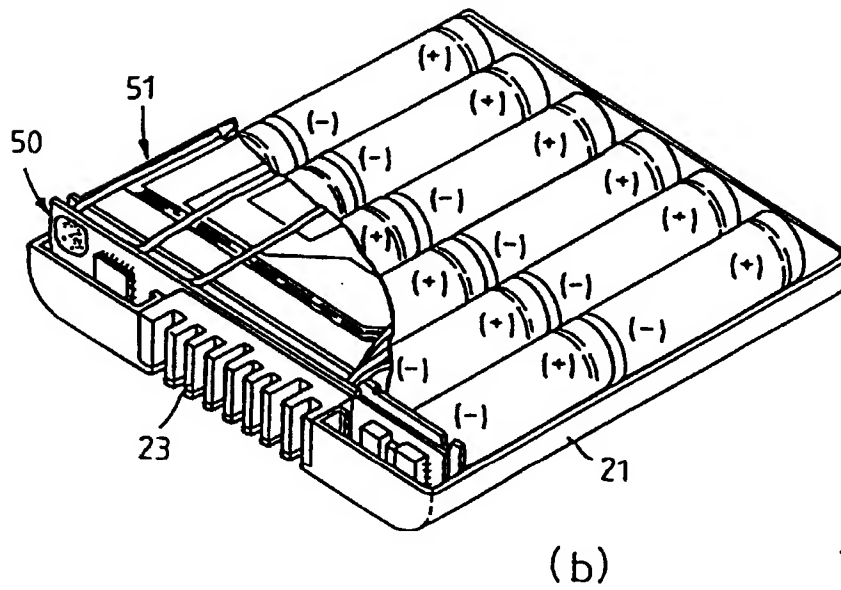
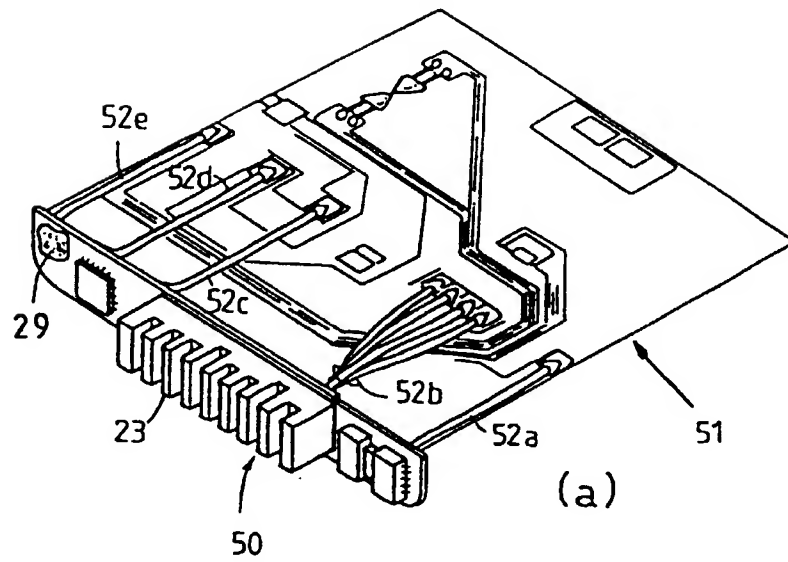


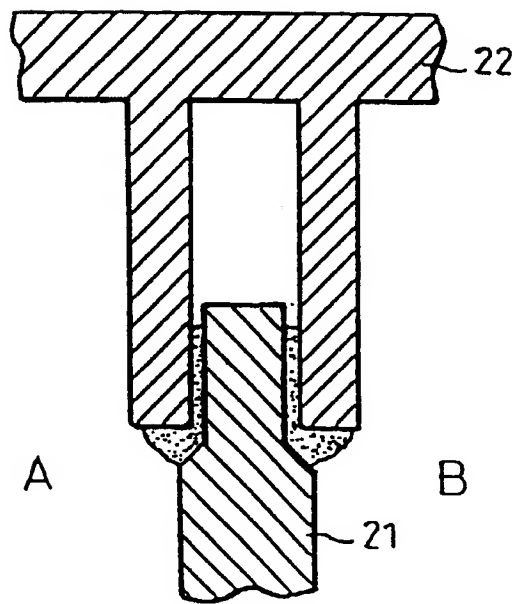
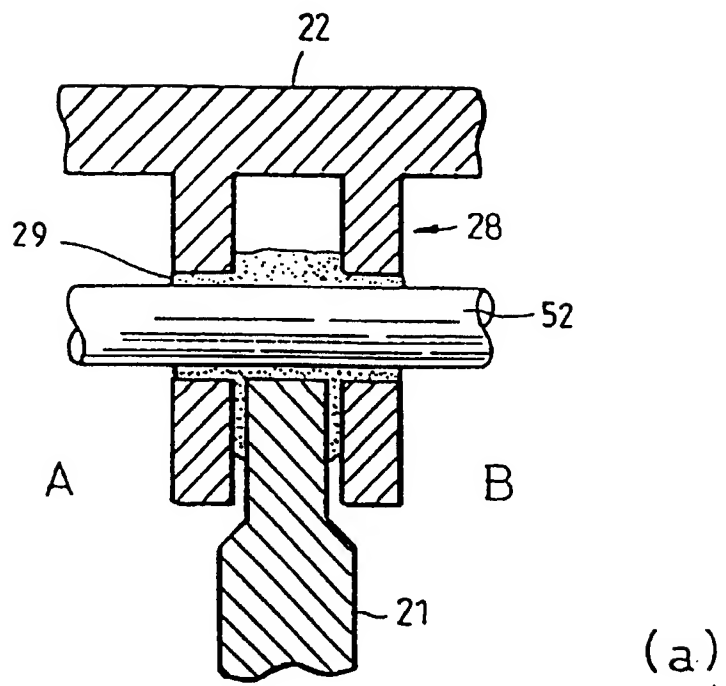
FIG. 3



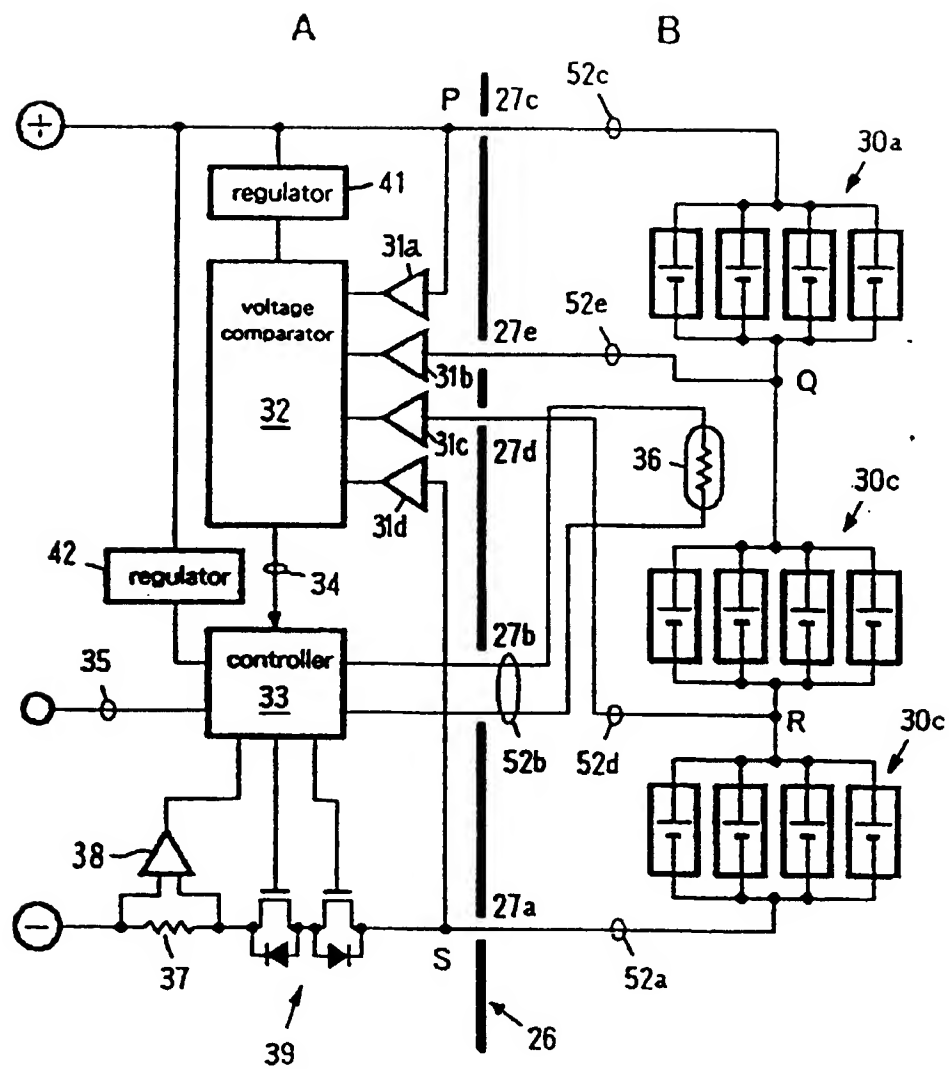
**FIG 4**



**FIG. 5**



**FIG. 6**

**FIG. 7**



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 96 30 2644

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	WO-A-95 08848 (MOTOROLA INC) * page 3, line 29 - page 6, line 6 *	1 3,4	H01M10/48 H01M2/10
Y	DE-A-30 15 751 (BERGWERKSVERBAND) * claims 1,2 *	3,4	
Y	EP-A-0 545 747 (TEXAS INSTRUMENTS) * page 8, line 28-39 *	1,3	
Y	US-A-4 325 106 (WILLIAM BARTUNEK) * column 5, line 24-36 *	1,3	
X	DE-A-38 44 390 (PITWAY CORP) * column 3, line 27 - column 4, line 66 *	1,2	
X	EP-A-0 565 217 (AUERGESELLSCHAFT GMBH) * the whole document *	1,3	
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31 July 1996	Examiner De Vos, L
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons * : member of the same patent family, corresponding document	

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